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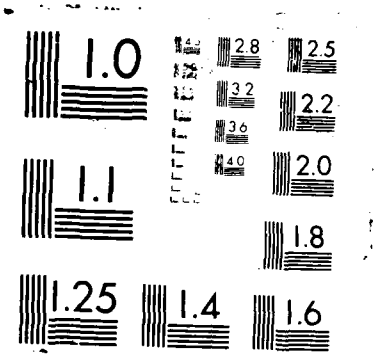
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DREDGING OPERATIONS TECHNICAL SUPPORT PROGRAM

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THE CORPS' ENVIRONMENTAL EFFECTS OF DREDGING PROGRAMS

by

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This report presents a broad program-level overview and documentation of the 1986-87 activities of the Environmental Effects of Dredging Programs. The current thrusts of the programs are field assistance through the Dredging Operations Technical Support (DOTS) Program technical assistance aspects, research through the Wetlands Research Program and the Long-term Effects of Dredging Operations Program, and field verification/demonstration through the DOTS dredged material management aspects and the Field Verification Program. These programs comprise the majority of the studies involved in evaluating the environmental effects of dredging and dredged material disposal.

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Preface

This paper summarizes the activities of the Environmental Effects of Dredging Programs (EEDP) during the period 1986-87. During the period, the EEDP was responsible for direct management of the Dredging Operations Technical Support (DOTS) Program, the Field Verification Program, the Long-term Effects of Dredging Operations Program, and the Wetlands Research Program. Funding for development of this document was provided by the US Army Corps of Engineers DOTS Program. The DOTS is sponsored by the Dredging Division of the Water Resources Support Center, Fort Belvoir, Va., and is assigned to the WES under the purview of the Environmental Laboratory's (EL) EEDP.

The report was prepared by Dr. Robert M. Engler, Mr. Thomas R. Patin, and Mr. Russell F. Theriot of the Program Managers' Office of the EL. The writers are grateful to Dr. Raymond Montgomery, Chief of the Environmental Engineering Division, EL; Dr. Hanley K. Smith of the Environmental Resources Division, EL; and Dr. Douglas Gunnison of the Ecosystem Research and Simulation Division, EL, for their efforts in reviewing the original manuscript. The report was edited by Ms. Jessica S. Ruff of the Information Technology Laboratory.

This report was compiled under the general supervision of Dr. John Harrison, Chief, EL. Dr. Robert M. Engler was Manager, EEDP; Mr. Thomas R. Patin was the DOTS Coordinator.

COL Dwayne G. Lee, CE, was the Commander and Director of WES. Dr. Robert W. Whalin was Technical Director.

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Contents

THE CORPS' ENVIRONMENTAL EFFECTS OF DREDGING PROGRAMS

Introduction

Background

1. Before the early 1970s, little was known of the environmental effects of dredging and dredged material disposal. Consequently, there was no sound technical or scientific basis for regulating the disposal of dredged material, and often regulations were excessive and counterproductive. This problem was recognized by the Congress of the United States, and the US Army Corps of Engineers was directed to conduct a comprehensive research program. The Dredged Material Research Program (DMRP) was to develop procedures for determining the environmental consequences of dredged material disposal and to develop new or improved methods for minimizing adverse effects.

2. The Corps was given the lead responsibility for conducting the research since, in the United States, the Corps is responsible for maintaining over 25,000 miles (40,000 km) of waterways and 1,000 harbors involving the annual disposal of 250 to 300 million cubic yards (191 to 229 million cubic metres) of dredged material. In addition, the Corps regulates the disposal of dredged material in waters of the United States including ocean waters. Approximately 14,000 dredging-related permit applications are processed annually by the Corps. Although the Corps regulates disposal, the regulations are based on guidelines and criteria developed jointly by the Corps and the US Environmental Protection Agency (USEPA). Therefore, results of the DMRP and other programs described in this paper are the major technical base from which regulations are developed.

3. This paper describes the major programs addressing environmental effects of dredging and disposal and dredge or fill activities subject to Section 404 of the Clean Water Act and Section 103 of the Ocean Dumping Act that have been or are being conducted by the Corps since 1973. These are:

a. Dredged Material Research Program.

b. Dredging Operations Technical Support Program (DOTS).

c. Long-term Effects of Dredging Operations Program (LEDO).

d. Wetlands Research Program (WRP).

e. Field Verification Program (FVP).

f. Dredging Contaminated Sediment Work of the Improvement of Operations and Maintenance Techniques (IOMT) Program.

All of these programs have been or are being conducted by the Environmental Laboratory (EL) of the US Army Engineer Waterways Experiment Station (WES) in Vicksburg, Miss., using contractual and in-house research and development capabilities. The EL has evolved into an internationally recognized center of excellence for studies related to the environmental effects of dredging and dredged material disposal. All current research and programs are under the centralized management of the Environmental Effects of Dredging Programs (EEDP).

Dredged Material Research Program

4. The Corps initiated the DMRP in 1973 and successfully completed the program in 1978 at a cost approaching $33 million. The DMRP was designed to be applicable nationally, to include all major types of dredging activities, regions of the country, and environmental settings. The program resulted in first-generation procedures for evaluating the physical, chemical, and biological impacts for a variety of disposal alternatives in water, on land, and in wetland areas. It produced tested, cost-effective methods and guidelines for assessing and minimizing the impacts of conventional disposal alternatives. At the same time, the DMRP demonstrated the viability and limits of new disposal alternatives, including the beneficial use of dredged material as a natural resource. New or improved procedures were developed for designing, constructing, and managing confined disposal areas to maximize service life and minimize adverse environmental impacts. Procedures were developed to predict and minimize turbidity from dredged material disposal operations. Methods were developed to predict movement of dredged material in the aquatic systems. Guidance on creating habitat (such as wetlands) using dredged material was developed.

5. In addition to providing data and information needed to develop criteria and guidelines, two fundamental disposal management conclusions were reached. Studies conducted and experience gained in the post-DMRP years have supported these conclusions. The first conclusion is that no single disposal alternative is most suited for a region or a type of project. Conversely, there is no single disposal alternative that can be dismissed as environmentally unsatisfactory due to potential impacts. In other words, from a technical standpoint there is no inherent effect or characteristic of an

alternative disposal method that precludes its consideration before specific site assessment. This conclusion holds true for ocean disposal, confined disposal, or any other alternative.

6. The second fundamental conclusion relates to long-term management strategy. To address a variety of environmental factors and considerations adequately, long-term regional strategies are required for effective disposal of dredged material. Through use of disposal management plans that consider project types, dredged material characteristics, disposal alternatives, and other factors, the best opportunity exists for maximum environmental protection at an acceptable cost.

7. In summary, the results of the DMRP provided the first definitive information on the impacts of dredged material disposal and on methods to minimize any adverse effects. This technology was made available to the users in the form of technical reports and synthesis reports. Over 250 technical reports were published on program results.

Dredging Operations Technical Support Program

8. The Corps established the DOTS Program as a technology transfer vehicle to assist the field in implementing the DMRP research results. Advisory assistance is provided, through DOTS, to all elements of the Corps to deal with environmental problems associated with dredging and dredged material disposal. Since DOTS was formed in 1978, over 1,200 requests for assistance from Corps operating elements have been acted upon. The program provides assistance to other Corps offices, such as field elements (Districts, Divisions, etc.), the Office of the Chief of Engineers, the Water Resources Support Center (WRSC), and other special interest groups. DOTS assistance covers such functions as briefings and conduct of seminars, development of study plans and project monitoring strategies, preparation of guidelines and criteria for regulatory programs, technical review of reports, management plans for disposal areas, litigation, etc.

9. During recent years the DOTS dredged material monitoring and assessment work has been changed from a necessary long-term follow-up to the DMRP to a complete dredged material management approach. The specific management tasks address high-priority technology application needs of the field. At the same time the management tasks have become a routine part of field application as the Corps finds itself facing new disposal management decisions brought on

by even more environmentally complex problems and regulations. Based on these changing field needs, recommendations from the Chief of Engineers' Environmental Advisory Board, and guidance from the Dredging Division of the WRSC, a complete Dredged Material Management structure is presented that will guide the assessment and technical application tasks of the DOTS Program. Additionally, this effort will involve the integration of ongoing case studies, field demonstrations, field strategy meetings, the LEDO Research Program, the FVP, the Environmental Impact Research Program, the WRP, and DOTS technology responses into field-tested management methods for economically and environmentally sound disposal of dredged material.

10. The objectives are twofold: (a) to continue to address high-priority technology application needs of the field and (b) to orient and direct the various tasks toward application of a complete long-term management strategy for the evaluation and assessment of multimedia disposal of dredged material.

11. The following eight high-priority technology needs are being pursued at this time within the Dredged Material Management aspects of the DOTS Program.

a. Optimization of dredging and dredged material disposal (1987-90). This task involves field demonstrations to refine procedures for designing, operating, and managing dredged material containment areas to meet required effluent suspended-solids standards and to provide adequate storage volume. Field site measurements are used to refine various predictive methods for volumetric sizing, estimating hydraulic efficiency, and predicting long-term storage capacity of containment areas. Definitive guidance has also been developed for predicting the dewatering potential of upland contained sites.

b. Beneficial uses of dredged material (1987-90). This task is concerned with identifying, applying, and verifying management plans for various beneficial uses of dredged material. Presently, monitoring continues at beneficial uses wetland and upland habitat development sites constructed using dredged material. At each site, plant and benthic community and soil characteristics are compared with those at reference areas. In addition, strategies are being developed for the conventional and innovative use of dredged material to develop and/or enhance natural resources. These uses include, but are not limited to, such resources as fisheries, wildlife, agriculture, forestry, and horticulture. Specific guidance is available for many of the existing beneficial uses.

c. Seasonal restrictions on dredging (1987-89). This task examines the applicability, necessity, and scope of restrictions to

both new work and operation and maintenance dredging and dredged material disposal. Although restrictions exist in almost every Distri t, very little information about the impacts of the dredging process on the resources is available. Criteria will be developed that could be used for applying restrictions where a technical information base is adequate.

d. Automated Dredging and Disposal Alternative Management System (ADDAMS) (1987-90). ADDAMS is designed to provide the field with a user-friendly computerized tool for the design, evaluation, and management of site-specific and areawide dredged material disposal alternatives. It presently incorporates four management/design techniques for upland confined disposal facilities management, in addition to a module for predicting short-term sediment dispersion due to open-water disposal. In the future it will include all techniques and methods that lend themselves to computerization.

e. Dredged material chemical testing cost reduction (1987-89). This task is concerned with reducing the costs of chemical testing while providing the basic information for an appropriate evaluation of the environmental impact of dredged material disposal. Areas of interest will include but will not be limited to: (a) the use of less expensive physical and/or chemical tests, (b) the use of one compound to relate the distribution of other similar type compounds, (c) the use of a tiered approach to testing, and (d) the use of special sediment sampling procedures to better characterize the areas of concern. Guidance on techniques to reduce chemical testing will be produced.

f. Practical application of sediment transport models (1987-88). This task will develop practical, economical application of sediment transport models for long-term movement of sediments from aquatic disposal mounds. Nomographs will be developed to aid in predicting sediment transport. In addition, subsequent field testing may be required to verify the nomographs. The following parameters will be included in the nomograph development: (a) tidal elevations, (b) storm surge, (c) tidal currents, (d) storm currents, (e) wind magnitude and direction, (f) wave conditions, (g) bottom sediments characteristics, and (h) water depth.

g. Guidelines for biological and physical monitoring of aquatic disposal (1987-90). This task will develop guidelines for the biological and physical monitoring of aquatic sites. The guidelines will be developed by integrating present knowledge about existing capabilities, tools, and techniques, and the results of field tests and experience. Options will be presented on a tiered basis and will cover a range of possible plans, from minimum requirements to an intensive, state-of-the art monitoring scenario for problem dredged material. Guidance will reflect the financial and time limitations resulting from such monitoring plans.

h. Review of contaminant fate models (1987-88). This task will review and provide guidance in the use of the types of models, as recently required by the USEPA, that are appropriate for application to Corps dredging-related projects.

12. Although the dredged material management effort presently consists of the above eight tasks, it incorporates the knowledge of many years of experience and research and development and can, if the need arises, be modified to address other high-priority needs.

Current Research

Background

13. The DMRP addressed and answered the critical environmental issues defined in the early 1970s. Subsequent regulatory research efforts under DOTS provided technical information used by the Corps and the USEPA in conducting dredging and disposal evaluations required by Federal legislation. However, neither the DMRP nor the regulatory research conducted under DOTS addressed, to the level necessary, all questions on environmental impacts associated with dredging or dredged material disposal.

14. The need to continue research on the environmental consequences of dredged material disposal was stated by the Corps during Congressional hearings in early 1980. The Congress, as a result of testimony received, expressed concern over the long-term environmental effects of dredged material disposal in some instances. In addition, international agreements such as the London Dumping Convention (international treaty) require consideration of chronic or sublethal effects in the evaluation of dredged material disposal in the oceans. Presently, the state of the art allows for accurate measurement of bioaccumulation, but does not provide for predicting the potential bioaccumulation into organisms of chemicals from sediments. In addition, current evaluative protocol regards any bioaccumulation as an adverse impact because there is no sound technical basis for interpreting the ecological significance of uptake. Other sublethal effects are not being addressed by the regulatory program because of the lack of state-of-the-art, field-verified procedures. The lack of defined and acceptable testing procedures that allow for an accurate assessment of the ecological significance of these effects has led to

interpretative data conflicts among regulatory agencies and litigation on Federal projects.

15. To address the concerns expressed by the Congress, and the need to have a sound technical basis for managing highly contaminated dredged material and promulgating the legislatively mandated regulatory mission, the Corps has initiated four programs: LEDO, WRP, FVP, and a work unit under the IOMT program that addresses methods of dredging contaminated sediments.

Long-term Effects of
Dredging Operations Program

16. The objectives of LEDO are to provide new or improved state-of-the-art technology for predicting long-term environmental impacts of dredging operations and to improve and develop methods for minimizing any adverse impacts associated with dredged material disposal. Research is currently being conducted to determine the effects of aquatic and upland disposal. LEDO is planned as a continuing program, as applied environmental research must be responsive to the dynamic nature of current pollution problems and research priorities must as a consequence be responsive to these needs.

17. Specific areas of research in LEDO include the following:

a. Bioaccumulation (uptake) and biomagnification (transfer) in the aquatic environment including effects interpretation. Establish the significance of bioaccumulation and biomagnification in aquatic organisms of toxic materials associated with the aquatic disposal of contaminated dredged material. Develop or improve predictive techniques for estimating the potential bioaccumulation of toxic chemicals from sediment.

b. Development and assessment of procedures to reduce adverse impacts. Laboratory and field test existing procedures that will eliminate or minimize adverse impacts of dredged material disposal. Capping of contaminated dredged material with clean dredged material is an example of an innovative procedure that the London Dumping Convention allows, provided continuing research is conducted.

c. Upland plant and animal bioassay procedures. Improve first-generation plant and animal bioassays for predicting uptake of contaminants from dredged material in wetland and upland disposal areas.

d. Effluent quality. Increase the understanding of the geochemical changes that occur with time in upland dredged material containment areas; develop or improve techniques for predicting contaminant concentrations in the effluent from diked dredged material containment areas. The development of mixing zone technology is also included in this work.

18. Research results will provide a broadened state-of-the-art technical basis for the Corps' implementation of its environmental regulatory responsibilities under Federal legislation. Additionally, technically updating the Ocean Dumping Implementation Manual and providing a Section 404 Clean Water Act implementation manual are program objectives. Emphasis will be placed on presenting research results in the domestic and international technical and scientific literature as well as making results immediately available to the field through innovative Corps technology transfer channels.

Wetlands Research Program

19. The WRP has two main objectives. The development of improved and standardized techniques to assist Corps field personnel in the identification, assessment, and quantification of wetland functions and values. Both objectives are designed primarily to meet the needs of the Section 404 regulatory program; however, their application extends to planning, construction, and operational activities within the Corps. The first objective was essentially completed with the publication "Corps of Engineers Wetland Delineation Manual" (WES Technical Report Y-87-1). Training is offered to Corps personnel in the interpretation of the technical aspects and methods described in the manual. The manual is presently being evaluated by the Districts for a 1-year period, after which necessary revisions will be made.

20. The emphasis in the WRP is now on the second objective: the assessment and measurement methodologies for wetland functions and values. Previous WRP research has consisted of evaluating existing assessment techniques, surveying needs, identifying technical data gaps, and completing a nationwide research plan. The research plan identifies and prioritizes Corps wetlands values information needs. The highest priority wetlands research identified in the plan is under way and consists of determining selected physical, chemical, and biological functions in bottomland hardwood forests of the southeastern United States. The primary study area is the Black Swamp area of the Cache River in Arkansas.

21. A major product of the functions and values research is the Wetland Evaluation Technique (WET). WET is a national procedure for identifying the probability that a given wetland can perform separate functions. These functions address different aspects of hydrology, water quality, and fish and wildlife habitat. Research results derived from the Cache River investigation

and similar studies will provide specific information needed to field verify and refine WET.

Field Verification Program

22. During planning of LEDO field investigations with the Corps' New England Division, it became apparent that a unique set of circumstances existed in the New England region. The environmental effects of disposal of highly contaminated dredged material from a single location could be evaluated, at the same time, under three disposal alternatives (open-water disposal, upland disposal, and wetland creation). The FVP was established as a cooperative effort among the Corps' New England Division, the WES, and the USEPA to field verify existing predictive testing procedures. Through the program, promising procedures already developed by the Corps along with techniques developed by USEPA for nondredged material were applied to project conditions at Black Rock Harbor, Bridgeport, Conn., using dredged material from a single highly contaminated maintenance dredging operation. Although the three disposal alternatives were evaluated independently during the DMRP, the FVP investigations provided the first opportunity for direct comparison of the environmental consequences using the same dredged material under such a broad range of disposal conditions.

23. The program's major areas of investigation include:

a. Bioaccumulation of contaminants by aquatic animals. Levels of bioaccumulation of selected contaminants over time, biological and physical factors affecting bioaccumulation, and variability of bioaccumulation predictions were documented in the laboratory. Bioaccumulation was then determined under field conditions and compared with laboratory predictions to verify the accuracy of the prediction methods.

b. Consequences of bioaccumulation in aquatic animals. Physiological indices of biological health were assessed in organisms that have accumulated contaminants from dredged material. These indices, previously developed by USEPA for use in nondredged material regulatory programs, included scope for growth, sister chromatid exchange, reproductive effects, effects on enzyme systems, and histopathological parameters. The responses of aquatic animals to contaminants are being determined in the laboratory to establish feasibility for assessing dredged material and correlation with bioaccumulation. Responses were then investigated in aquatic organisms exposed to contaminated sediments in the field.

c. Effects of aquatic disposal on community structures. Effects of contaminated dredged material disposal on community structures were determined by measuring mortality, reproduction, and

intrinsic rate of growth in selected populations within aquatic communities. These assessments were documented in the laboratory and investigated in the field for the purpose of documenting verification.

d. Effects of upland disposal on water quality. Laboratory tests for predicting effluent quality were conducted on contaminated sediment prior to placement in a confined disposal area. The confined disposal area was designed, constructed, operated, and managed to ensure optimum fill configuration for the field studies and evaluation of effluent quality effects. During filling operation, influent and effluent water quality parameters were monitored extensively at selected stations within the disposal area. Following disposal, the quality of surface water runoff was being determined by collecting surface water samples from controlled simulation of rainfall. Monitoring wells were placed around and within the disposal area, and ground-water samples were taken before, during, and after filling.

e. Bioaccumulation of contaminants in upland and wetland plants. First-generation test procedures from DOTS and other studies were investigated at the field site. Saltmarsh plants were also grown under controlled wetland and upland conditions and analyzed for contaminant bioaccumulation. Field investigations were conducted to verify laboratory test results. Saltmarsh plants will be planted at the upland disposal facility at Black Rock Harbor and sampled each growing season to determine contaminant bioaccumulation.

f. Bioaccumulation of contaminants in upland and wetland animals. Existing upland and wetland animal bioassay test procedures developed in Europe were investigated in the field using selected upland and wetland animals.

24. Results of the FVP will provide both the Corps and USEPA with documented and verified state-of-the-art procedures and interpretive guidance for complying with national regulatory requirements and international conventions and agreements. This guidance will be incorporated into the Corps regulatory program through WES Technical Reports, Miscellaneous Papers, the EEDP Technical Notes, and through field office requests for DOTS technical assistance.

Dredging Contaminated Sediment

25. In the United States, much work has been conducted over the past 15 years on the effects of dredged material disposal. However, minimum work has been conducted on the effects of the dredging operation because it was assumed that the disposal operation would have the most significant impact. However, due to the need to dredge highly contaminated sediment, research was required to identify environmental parameters associated with conventional dredges as well as investigating and developing procedures and equipment to

minimize adverse effects associated with the dredging operation. This study was incorporated into the IOMT, another major program in the Corps of Engineers.

26. Existing data on the resuspension of sediments and contaminants are being collected on a national and international basis. In addition, field studies are being conducted at various sites where unconventional equipment is being used. Based on these data, guidelines will be developed for dredging highly contaminated sediments to minimize any adverse impacts.

Summary

27. Prior to the 1970s, little research was conducted by the Corps of Engineers, or by other agencies, on the environmental effects of dredging and dredged material disposal. Within the past 15 years, major research has been conducted and is continuing in high-priority areas. The Corps has a three-element approach to better understanding the environmental impacts of dredging operations. Through DOTS, direct field assistance is available and a dredged material management program places the research developed in a user-oriented framework. Research is conducted under LEDO and the WRP, while results are verified under FVP. The Corps of Engineers has, through the EEDP, an innovative and active technology transfer program through the mechanism of providing direct technical assistance to the field, and a means to address high-priority research needs on a continuing basis.

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